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Most Chemists are involved in either research and development or production. In research and development, Chemists study the composition, structure, and properties of substances and the interactions between them. They search for new information about materials and look for ways to put this knowledge to practical use. They apply scientific principles and techniques using specialized instruments to measure, identify, and evaluate changes in matter. Chemists working in applied research use their knowledge to improve and create new products.

Chemists also work in production and quality control in manufacturing plants. They prepare instructions for plant workers that specify ingredients, mixing times, and temperatures for each stage in the manufacturing process. They also monitor automated processes to ensure proper product yield, and test samples of raw materials or finished products to make certain that they meet industry or government standards.

Chemists often specialize in one of the following areas:

- ▶ Organic Chemists work with carbon and its compounds, mostly derived from animals and plants. These Chemists develop commercial products such as pharmaceuticals, plastics, and fertilizers.
- ▶ Inorganic Chemists work with compounds of non-carbon structure, including most of the metals and minerals. In the electronics industry, they work on ways to build solid state electronic components.
- ▶ Physical Chemists study the relationships between the chemical and physical properties of substances. These chemists are helping to develop new energy sources.
- ▶ Analytical Chemists examine the content of substances and measure the amount of each component present. These chemists also identify the presence of chemical pollutants in air, water, and soil.
- ▶ Cereal Chemists are specialists in the use of cereal grains in foods. They examine raw materials and products using cereals such as corn, wheat, oats, rice, and rye.

Chemists

Tasks

- ▶ Analyze organic and inorganic compounds to determine chemical and physical properties, composition, structure, relationships, and reactions, utilizing chromatography, spectroscopy, and spectrophotometry techniques.
- ▶ Develop, improve, and customize products, equipment, formulas, processes, and analytical methods.
- ▶ Compile and analyze test information to determine process or equipment operating efficiency and to diagnose malfunctions.
- ▶ Confer with scientists and engineers to conduct analyses of research projects, interpret test results, or develop nonstandard tests.
- ▶ Direct, coordinate, and advise personnel in test procedures for analyzing components and physical properties of materials.
- ▶ Induce changes in composition of substances by introducing heat, light, energy, and chemical catalysts for quantitative analysis.
- ▶ Write technical papers and reports; prepare standards and specifications for processes, facilities, products, and tests.

Detailed descriptions of this occupation may be found in the Occupational Information Network (O*NET) at online.onetcenter.org.

Important Skills, Knowledge, and Abilities

- ▶ Science — Using scientific rules and methods to solve problems.
- ▶ Complex Problem Solving — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.
- ▶ Reading Comprehension — Understanding written sentences and paragraphs in work-related documents.
- ▶ Quality Control Analysis — Conducting tests and inspections of products, services, or processes to evaluate quality or performance.
- ▶ Chemistry — Knowledge of the chemical composition, structure, and properties of substances and of the chemical processes and transformations that they undergo. This includes uses of chemicals and their interactions, danger signs, production techniques, and disposal methods.
- ▶ Mathematics — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.
- ▶ English Language — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.
- ▶ Computers and Electronics — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.
- ▶ Deductive Reasoning — The ability to apply general rules to specific problems to produce answers that make sense.
- ▶ Inductive Reasoning — The ability to combine pieces of information to form general rules or conclusions (includes finding a relationship among seemingly unrelated events).
- ▶ Oral Comprehension — The ability to listen to and understand information and ideas presented through spoken words and sentences.
- ▶ Oral Expression — The ability to communicate information and ideas in speaking so others will understand.

Work Environment

Chemists usually work regular hours in well-lit, well-equipped laboratories, offices, or classrooms. They may work additional or irregular hours when working on special research projects. Chemists may perform some of their research in a chemical plant or outdoors, while gathering water samples to test for pollutants, for example. Chemists are exposed to health or safety hazards when handling certain chemicals such as highly caustic or potentially explosive chemicals. However, risks are minimal when protective gear is worn and proper safety procedures are followed.

California's Job Outlook and Wages

The California Outlook and Wage table below represents the occupation across all industries.

| Standard Occupational Classification | Estimated Number of Workers 2004 | Estimated Number of Workers 2014 | Average Annual Openings | 2006 Wage Range (per hour) |
|--------------------------------------|----------------------------------|----------------------------------|-------------------------|----------------------------|
| Chemists | | | | |
| 19-2031 | 9,300 | 10,600 | 430 | \$22.24 to \$40.25 |

Wages do not reflect self-employment.

Average annual openings include new jobs plus net replacements.

Source: www.labormarketinfo.edd.ca.gov, Employment Projections by Occupation and OES Employment & Wages by Occupation, Labor Market Information Division, Employment Development Department.

Trends

Employment of Chemists is expected to grow at about an average rate for all occupations over the 2004–2014 period. Within the chemical industry, job opportunities are expected to be most plentiful in pharmaceutical and biotechnology firms. Stronger competition among drug companies and an aging population are contributing to the need for innovative and improved drugs discovered through scientific research.

Training/Requirements/Apprenticeships

Chemists usually follow one of the following training paths:

- ▶ Bachelor's degree, in chemistry
- ▶ Master's degree
- ▶ Doctorate degree
- ▶ Extensive on-the-job training, in addition to a college degree

A bachelor's degree in chemistry or a related science discipline usually is the minimum educational requirement for entry-level chemist jobs. However, many research jobs require a master's degree or, more frequently, a Ph.D.

In government or industry, beginning Chemists work in quality control, perform analytical testing, or assist senior Chemists in research and development laboratories. Many employers prefer Chemists with a Ph.D., or at least a master's degree, to lead basic and applied research. Relevant work experience is also a helpful asset.

Chemists

Recommended High School Course Work

High school preparation courses in chemistry, biology, physics, environmental studies, algebra, geometry, trigonometry, statistics, and computer technology are helpful.

Where Do I Find the Job?

Direct application to employers remains one of the most effective job search methods.

Use the *Search for Employers by Industry* feature on the *Career Center* page at www.labormarketinfo.edd.ca.gov to locate employers in your area. Search under the following industry names to get a list of private firms and their addresses:

- ▶ Architectural Services
- ▶ Building Inspection Services
- ▶ Drafting Services
- ▶ Engineering Services
- ▶ In-Vitro Diagnostic Substance
- ▶ Landscape Architectural Services
- ▶ Other Biological Product
- ▶ Other Surveying and Mapping Services
- ▶ Pharmaceutical Preparation
- ▶ Physical/Engineering/Biological Research
- ▶ Social Science/Humanities Research
- ▶ Testing Laboratories

Search these **yellow page** headings for listings of private firms:

- ▶ Biotechnology, Products and Services
- ▶ Chemicals, Wholesale & Manufacturers
- ▶ Laboratories, Analytical
- ▶ Laboratories, Biological
- ▶ Laboratories, Research
- ▶ Laboratories, Testing

Where Can the Job Lead?

In private industry, Chemists with a bachelor's degree have the opportunity, with experience and additional training, to advance to a more responsible position. People with advanced degrees have greater opportunities for advancement. Chemists with a master's degree usually qualify for applied research positions and teaching positions in two-year colleges. A doctorate offers the best opportunities for higher levels of research and four-year college teaching positions.

Other Sources of Information

AACC International
www.aaccnet.org

American Chemical Society
www.acs.org

National Association of Manufacturers
www.nam.org

Pharmaceutical Research and Manufacturers of America
www.phrma.org

Society of Industrial Microbiology
www.simhq.org